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EFFECT OF ROSIN AND FLAX FIBERS ON THE IMPROVEMENT IN MECHANICAL PROPERTIES OF HYBRID POLYMERIC COMPOSITES

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ABSTRACT

This paper presents an experimental work on the development of natural fiber reinforced polymeric composites. The powdered rosin, flax fiber, sisal fiber and sunn hemp fiber are utilized as fillers or reinforcements with epoxy resin for making hybrid composites. The fiber and resin compositional proportion in each specimen are 1:1 while the epoxy resin and hardener composition is 10:1 respectively. In the first type of hybrid composite, only sunn hemp and sisal fibers were added and in the second type of hybrid composite rosin, flax, sunn hemp and sisal fibers were added. These fabricated hybrid composites were tested as per the ASTM standards in order to evaluate the mechanical properties such as hardness, impact strength, tensile strength and density in dry conditions. The result of tests show that the rosin and flax incorporated composite has better properties compared to the normal hybrid composite made using the other two fibers under the mechanical loadings. However, it was found that the inclusions of rosin and flax fiber could improve the mechanical properties.

KEYWORDS: Rosin, Polymer matrix composite (PMC), Mechanical Properties, Sunn Hemp Fiber, Sisal Fiber, Flax Fiber, Epoxy LY556 & Hardener HY951

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Original Article

1. INTRODUCTION

In this work, two hybrid composites were fabricated, tested and compared. One is rosin and flax fiber reinforced hybrid composite also having sunn hemp, sisal fibers. The other is named normal hybrid composite having only the reinforcements of sun hemp and sisal fibers without flax. The matrix component used in this investigation was epoxy type resin of grade LY556 and its suitable hardener namely HY951 supplied by the company called Laboratary chemicals, Chennai. These reinforcement materials were obtained from local markets in the raw format as shown in table 1. A composite material is a combination of two materials in which one of them is known as the reinforcing phase, in the form of fibers, sheets, or particles, and is incorporated in the other materials namely the matrix phase. The reinforcing element and the matrix component can be a metal, ceramic, or polymer. Composites normally have a fiber or particle phase has more stiffness and strength compared to the continuous kind of matrix phase and always serves as the major load carrying members. The matrix acts often as the load transferring medium among fibers, and in most of the less ideal cases where the loads have complex nature, the matrix may have to

withstand loads transverse to the place of fiber axis. The matrix has more ductility than the fiber elements and thus always acts as a resource for the composite toughness. The matrix also serves to safeguard the fibers from environmental hazards before, during and after the processing of the composite. When properly designed, the new combination material shows better strength values than that is possible with the individual materials. Composites are used mainly not only for their structural characteristics, but also for the electrical, heat and environmental applications.

Rosin, is a naturally available material, also known as colophony and the Greek pitch meaning in Latin as the pix græca, is a solid natured resin normally obtained aprioristically from pine trees and some important variety of plants, in majority from the conifer trees, finally produced by means of heating method for fresh liquid resin in order to evaporate fully the volatile natured liquid known as terpene type of components. It is having the nature of semi-transparency in look and differs in color from yellow to dark black. At normal room temperatures, rosin has brittleness, but rosin melts readily often at stove-top temperatures. It mainly consists of various types of resin full acids, most often abiotic type of acid in its composition. Flax, also commonly known as flax or linseed, is a element of the genetic type Linum in the family called Linaceae. It is a food material and fiber kind of crop mostly cultivated in much cooler places worldwide. Textile materials made using flax are well known in the Western type countries as linen material, and traditionally utilized for making bed sheets, making underclothes, and making table linen. Sisal is a hard natured fiber extracted from the tree leaves of sisal kind of plants which are the perennial succulents that always grow well in hot natured and dry kind of places. Sisal is environmentally friendly fiber as it has the nature of biodegradability and almost nil pesticide materials and fertilizer materials are used in its very cultivation. World production of this is about 300 kilo tonnes. Sun hemp is mainly cultivated in India and also in several other countries and regions. The fiber is always extracted from the area of bast of the plant side through a process knowingly retting and the resource cummaturity value of the plant and the type of retting always govern the important properties of the fiber. These mentioned fibers were first purified through water treatment and then immediately powdered through grinding process. This information presents a full mechanical type of characterization for a hybrid composite material. Regulations for the mechanical and fracture type of characterization of these hybrid composite materials are provided clearly. Mechanical characteristics of composite materials were found in dry conditions. Rosin and its powder are indicated below in figure 1.



Figure 1: Rosin (Left) and Rosin Powder (Right)

2. METHODS

The raw fibers as shown in table 1 were broken down in the form of pieces and were first finely ground using a ball mill in order to produce fiber in powder form and then separated using mechanical sieving process into particle format.

2.2.1 Fiber Preparation

Raw fibers were initially cleaned with clear running water and then immediately dried. Then these aggregations were smoothly dispersed using hand gently. Its outer shell was removed using knife and was cut to get the required dimensions. Finally, it was measured for attaining proper weight and maintained.

Table 1: Natural Fiber Materials

Sun hemp Fiber



Sisal Fiber



Flax Fiber



Table 2: Materials

Material	Type	Supplied by
Matrix	Bio Epoxy resin	Laboratary chemicals Chennai (Matrix, hardener and releasing agent)
Catalyst	Hardener	
Releasing agent	Poly Vinyl Acetate	
Sunn hemp, sisal, flax	Fibers	Local markets, Chennai
Rosin	Natural resin	Local markets, Chennai

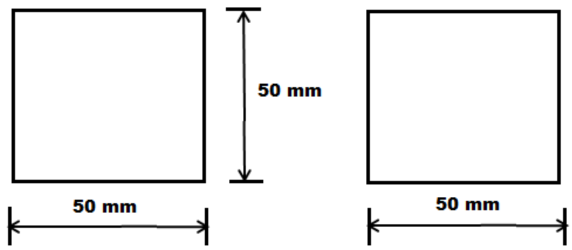
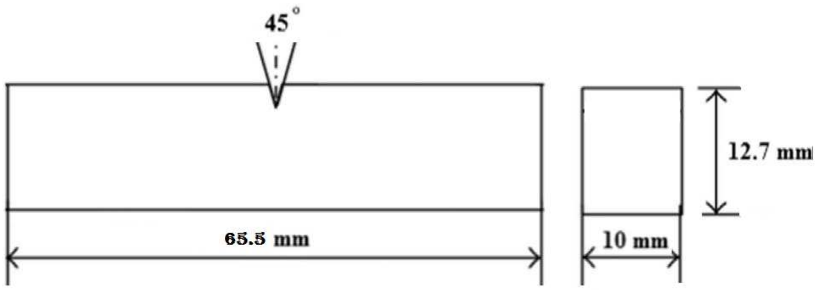
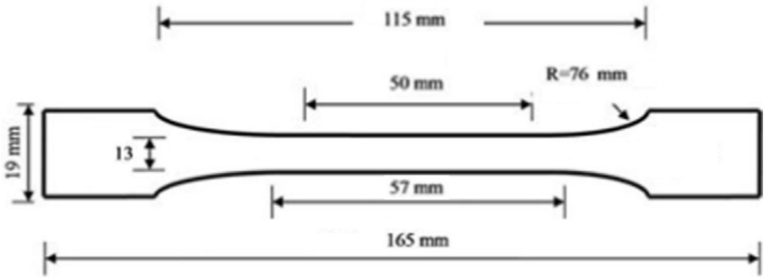
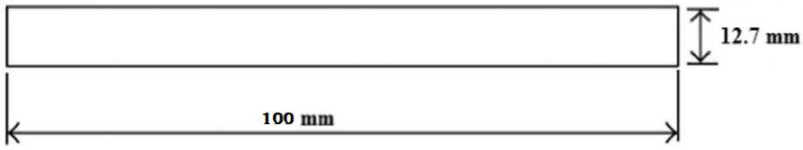
2.2.2 Polymer-Hardener Mixture Preparation

For getting quality composite, the method of measurement used for the samples should be accurate before mixing with better uniformity. Precise amount of polymer was taken as per calculations and 10% of hardener was added to it. This type of mixture was stirred fully until it becomes warmer. Very small extra quantity of hardener was taken for balancing any possible wastage in the process with more care.

2.2.3 Preparation of Specimens

The method of hand lay-up technique was utilized for making composites. The fiber piles were cut to the required sizes. The suitable numbers of fiber piles were correctly taken. Then these fibers were weighed and correctly the resin and hardener were also weighed. Epoxy resin and its hardener was mixed using sun hemp material rod using a bowl. More care was considered in order to avoid any formation of bubble materials. Because the formation of air bubbles in the process that were normally trapped in the matrix may result in material failure. The subsequent steps in the fabrication process mainly consist of first keeping a releasing type of film on to the mold surfaces. Then a polymer coating was immediately applied on the sheet tops. As the next step, fiber ply of one kind was introduced along with rosin particles on top and proper rolling action was done. Then resin materials was again applied, fiber ply of another type was allowed and rolled again. Rolling process was conducted using cylindrical mild steel rod materials. These procedural steps were repeated again and again until eight numbers of alternating fibers have been laid successfully. On the top of the last ply layer, a polymer coating was done which always serve to confirm a good surface finish on top. Finally, a clear releasing sheet was put again on the top and a light rolling action was performed. A 20 Kg of weight was rested on the composite for good compression action. It was left over for 72 hours' time duration for proper aging and curing actions.

Table 3: Specimen Preparation Standards

Test	Standard followed	Schematic Figure
Hardness testing	ASTM E 18-07	
Impact testing	ASTM D256	
Tensile testing	ASTM D638-03	
Flexural testing	ASTM D790	

3. TEST RESULTS AND DISCUSSIONS

3.1 Hardness Test

Porosity or atmospheric oxygen and thermal oriented deformation are caused by decreased hardness of the material. Therefore, it was important to get the sample with good hardness vales. Test samples were subjected to hardness testing using Shour D Micro Hardness tester using ASTM E 18-07. The sample was tested at three different locations with the test specimens being subjected to a load of 1/2 kg for a dwell time duration of 10 seconds for each location. The load range of the hardness testing machine is 10 g to 1kg with a least count of 0.01 mm. The average hardness value for flax fiber hybrid composite with rosin was found to be 70 and that of the normal composite having only sun hemp and sisal fibers was noted as 68.9. The plot of hardness values for the two different composites is given below in figure 2.

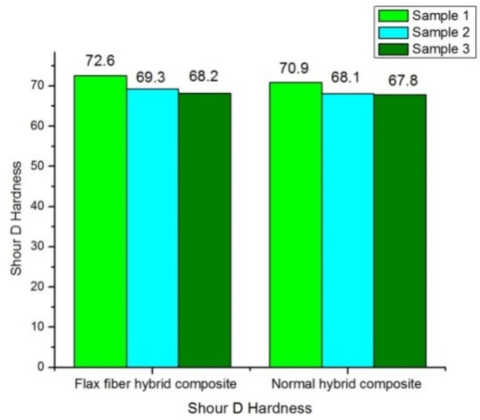


Figure 2: Hardness Test Results

3.2 Impact Test

The impact testing was carried out as per ASTM D 256 standard, using the Tinius Olsen Impact testing machine having 5.5 J pendulum. In this test, the specimen which is usually having notched structure is struck and immediately broken by the single blow in a specially designed type of machine. In this test, the energy absorbed while breaking was measured. The flax fiber with rosin reinforced hybrid composite absorbed an energy value of 20.53 J whereas the normal hybrid composite absorbed 19.86 J indicating the better value obtained by flax fiber one. The plot of impact strength values for the two different composites is given below in figure 3.

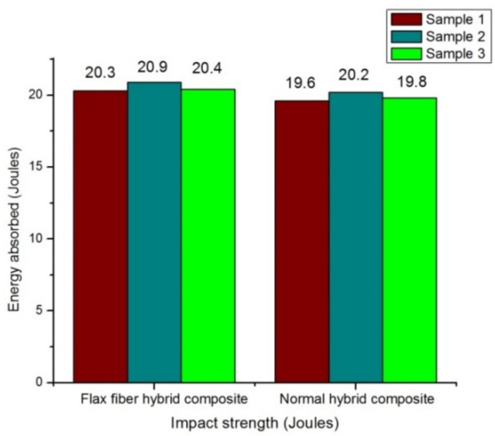


Figure 3: Comparison of Impact Strength

3.3 Tensile Test

The tensile testing was carried out using ASTM D638 standard, using the Universal Testing Machine (UTM) Instron 1195. The commonly used specimens for tensile testing are the flat type. During this testing, a uniaxial load was applied at both ends of the specimen. The speed of the test was kept at 5 mm/min. The tensile strength values of both flax fiber with rosin and normal composites were noted as 67.43 Mpa and 65.13 Mpa showing the superiority of flax fiber one. The plot of this tensile strength numerical values for the two different hybrid composites are given below in figure 4.

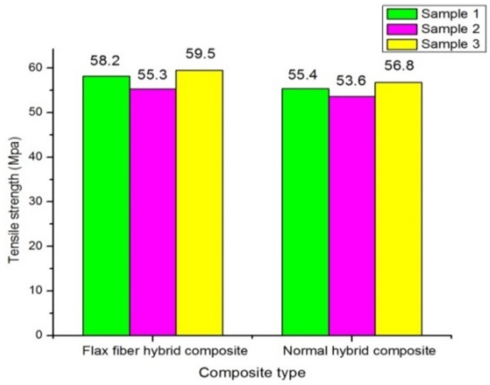


Figure 4: Comparison of Tensile Strength

3.4 Flexural Strength Test

The flexural testing was carried out as per ASTM D790 standard, using the Universal Testing Machine, 5569A, Instron. The span length was kept as 50 mm and speed for test as 2 mm/min. The flax fiber reinforced hybrid composite with rosin has the highest flexural strength (13.86 MPa for dry condition) since its strength value increases with an increase in the inter-facial adhesion as clearly shown in figure 4 compared to other hybrid composites. The normal hybrid composite having only sun hemp and sisal fibers had the flexural strength value of 13.56 Mpa showing a comparatively lesser value than the flaxfiber hybrid composite. The plot of flexural strength values for the two different composites is given below in figure 5.

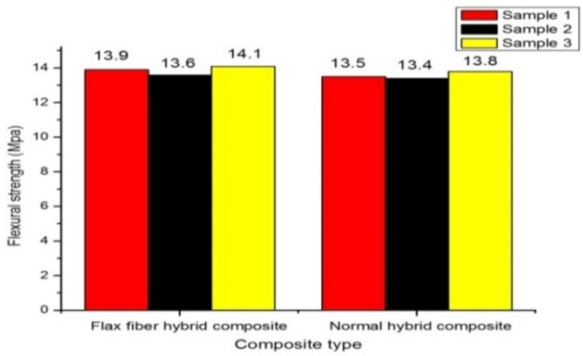


Figure 5: Comparison of Flexural Strength

3.5. Percentage of Elongation of Different Hybrid Composites

Figure 6 shows the percentage of elongation of hybrid composites in tensile testing is found to be more than that value of the hybrid composite made of normal sun hemp and sisal fiber composite (16.76% in dry condition). Therefore, flax fiber hybrid composite with rosincan withstand more amount of strain before failure in the tensile testing than the other kind of hybrid composite.

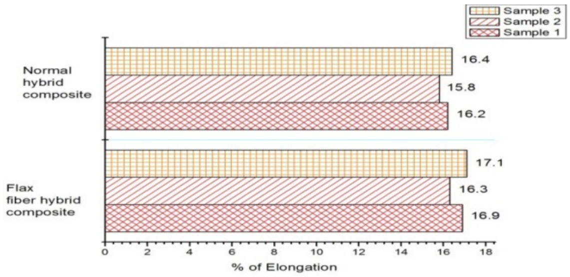


Figure 6

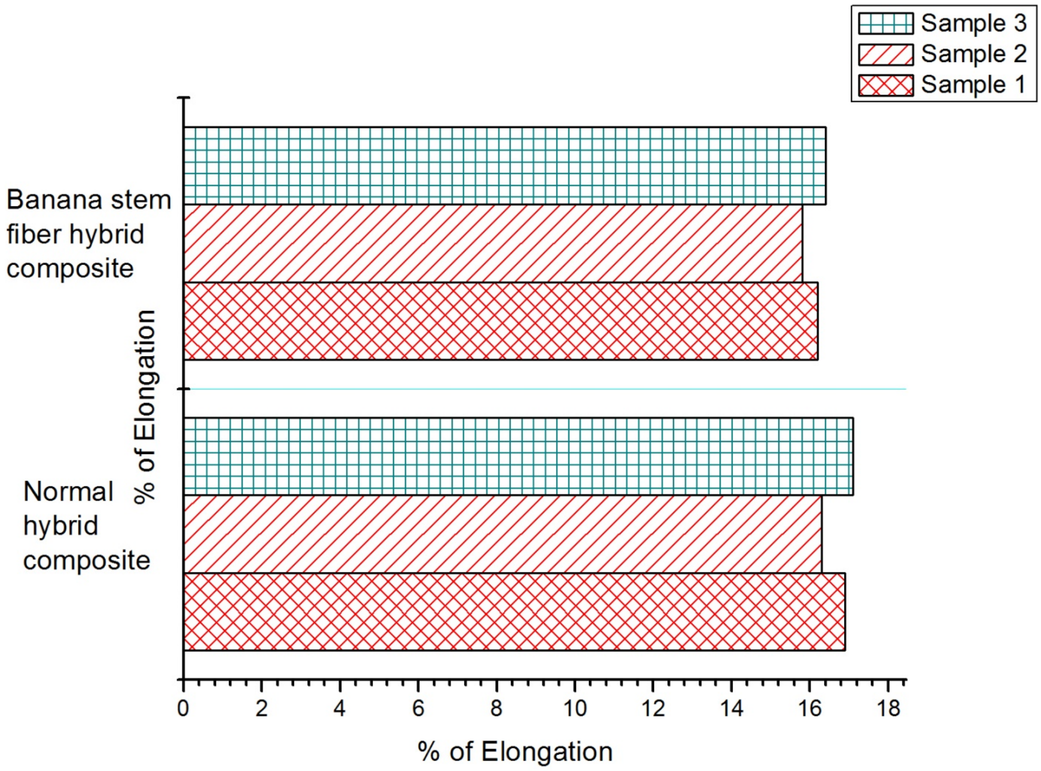


Figure 7: Comparison of % of Elongation

3.6 Comparison of Different Hybrid Composites: Break Load

The normal hybrid composite failed at 9.42 kN in the tensile testing and in the flexural test 2.3kN. In the double shear testing, at 9.23 kN the said composites failed. From this observation, the flax fiber hybrid composite with rosin withstands maximum loading compared to other hybrid composite as shown in figure 7.

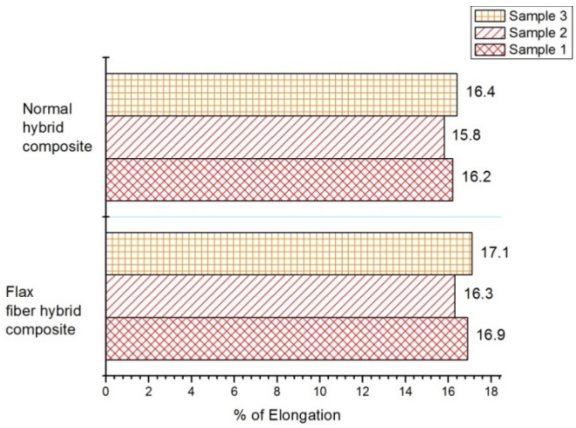


Figure 8: Comparison of Break Load Performance

The fabricated composite samples are shown below in figure 8.



Figure 9: Rosin and Flax (Left two) and Normal Hybrid (Right Three) Composite Samples

3.7 Archimedes Density Test

Archimedes' principle helps in the calculation of density by means of providing a convenient and accurate method for the purpose of determining the numerical volume value of irregularly shaped objects like rocks. This method is often commonly used in the construction industry knowingly Hydrostatic Weighing. A sample of the fabricated composite is taken for this purpose and the calculations are shown below.

P=density

M_1=weight or mass in air

M_2=weight or mass in water

The sample object is weighed in air and noted with M_1=7.12g

The sample was submerged in water and thereby found to have apparent mass M_2=5.06g

The sample was clear that it had displaced M_1-M_2=7.12-5.06=2.06g of water. Since water has density of 1g/cm^3,

This implies that volume of the object = 2.06 cm^3

Density of the object is then calculated as P=m/v=3.46/2.06=1.33g/cc

4. CONCLUSIONS

From the experimental results, rosin and flax fiber hybrid composite specimen possess good mechanical properties. It is found that the innovative incorporation of natural rosin and flax fiber can very much improve the properties. This research work could be further extended in future to study the tribological aspects and phenomena like abrasion behavior, wear behavior, hardness behavior. The possibility of using other type of potential fillers for development of hybrid kind of composites can be explored and evaluation of their mechanical behavior and erosion type of behavior and the resultant experimental findings and outputs can be similarly found and also analyzed. Investigation and research of the powder morphology and fracture surfaces of the composite specimens can be carried out using scanning electron microscopy. Generating wealth from waste materials, such as from the flax fibers, sisal fibers and sun hemp fibers etc should be regarded as one of the methodologies for creating eco-friendly and hazardless environment helpful for the future generation. Plastic by-products could be changed into natural fiber hybrid composites similar to the one used in this present research work in view for sustaining these natural resources and compliment extra financial gains for enterprises like small scale kind of farming industries. This change can be possible in the due course of such research work keeping in mind that there canbe no compromise in terms of quality and also safety in competitiveness with various business products and materials.

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